PERFORMANCE INVESTIGATION OF IC ENGINE WITH VARIABLE GEOMETRY TURBINE

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Abstract

The abstract Internal combustion engines have very important role in mechanical power generation, IC engines has major share in the power generation devices. Due to high torque and high speed requirement and new emissions standards, the IC engine technology changing very rapidly in these days. New technologies are incorporated in the IC engines to improve its performances. Turbocharging is one of the technologies to enhance power generation and reduce emissions, this technology is now familiar and adopted by the automobile industry but small advancements are continuously made in this technology by different researchers. In this paper, experimental study on IC engine with variable geometry turbine (VGT) is presented.

Keywords: **IC engine, Turbochargers, Air Fuel ratio, Fuel efficiency.**

1. INTRODUCTION

IC engines are primary source of mechanical energy in many applications, But this industry facing three major issues of pollution, low energy efficiency and fossil fuel depletion. In order to face these challenges methodologies and new technologies are being developed by the researchers. Air fuel ratio entering into the combustion chamber is a basic parameter which influences the combustion process. Controlling of Air fuel ratio has huge influence on the performance parameters and emissions of the IC engine. [1],[2]. To control air fuel ratio use of turbocharger is simple and sophisticated method. Use of turbocharger allows lean air fuel ratio to enter into the combustion chamber. Turbocharger consists of a compressor driven by the turbocharger working exhaust gas pressure. But compression of air leads to increase in its temperature which reduces performance gains achieved by the use of turbocharger. To avoid this intercooler is used.

The use of intercooler to cool the exhaust gases before supplying it to the turbine increases the effectiveness of the turbine. [4], [5]. Intercoolers are generally air cooled or water cooled but for effective cooling of exhaust gas methods like air conditioned assisted cooling can be employed. [6]. Turbocharging is usually employed for diesel engines but for spark ignition engines turbocharging is difficult to employ because of control issues. [7]

Port injection systems are also effective to improve the performance of the IC engine and to reduce knock and misfire. [3], [8]. IC engines technologies also facing issues of knock, excessive vibrations and misfire along with low efficiency and pollutions [9]. There is a huge need to explore the effect of turbochargers on the knock and misfire.

2. Turbocharger

Turbochargers have huge positive impact on the engine performance parameters and exhaust emission parameters.[10] Turbocharger is used to increase the air density entering into the combustion chamber, to increase the air density a compressor is used which is driven by a turbine mounted on the same shaft. The turbine is rotated by the hot exhaust gas emitted from the combustion chamber of IC engine. Fig. 1 shows the turbocharger used for this experimental study. This is variable geometry type of turbine.

Fig.1: variable geometry turbocharger

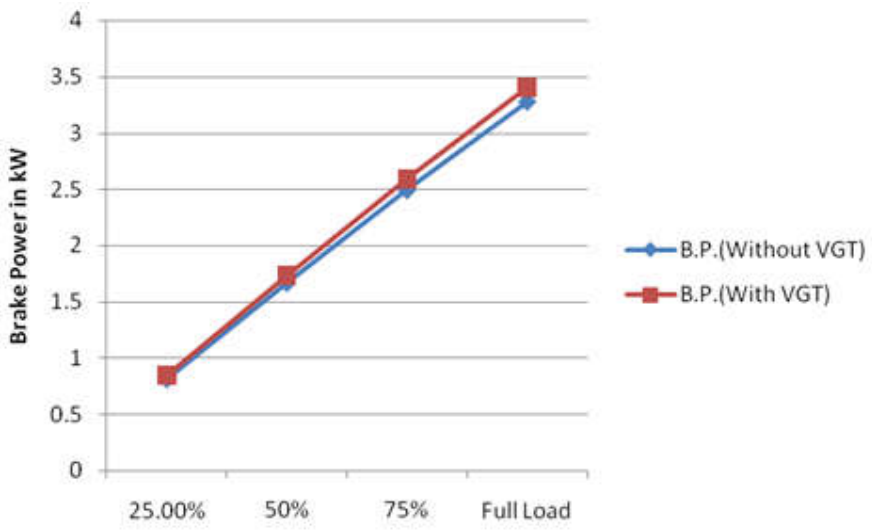
3. Experimental Investigation

Fig.2: Experimental Setup

To conduct this experimental study an experimental setup using variable geometry turbocharger is developed. Fig. 2 shows the figure of experimental setup. A 553 cc diesel engine, water cooled KIRLOSKAR made engine is used in this experimental setup. The diesel engine was properly instrumented with temperature indicators, orifice meter, rope break dynamo meter etc. The readings were taken by using these measuring instruments.

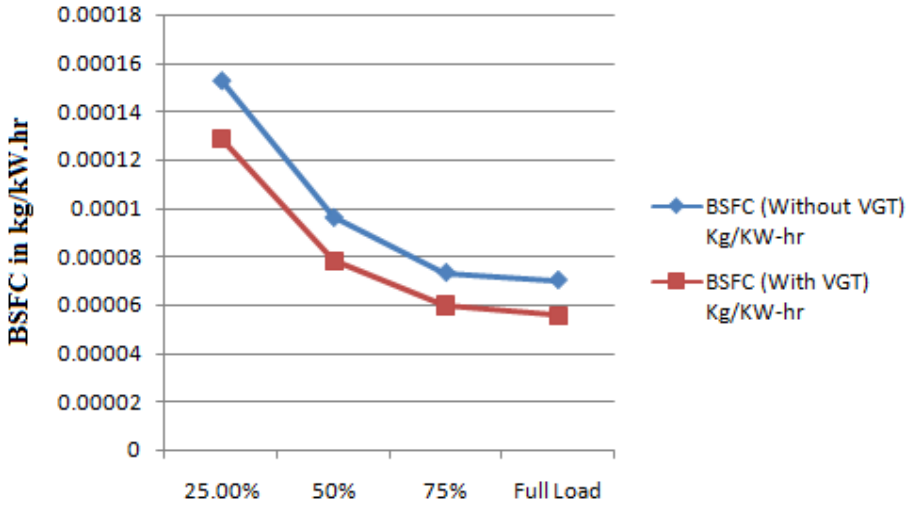
4. Results and Discussions

In this work, the engine performance has been studied for four different loading conditions 25% load, 50% load, 75% load and full load with and without turbocharger. The observation of the performance of this IC engine has taken and performance parameters like brake power, brake specific fuel consumption (BSFC) and Thermal efficiency are calculated.



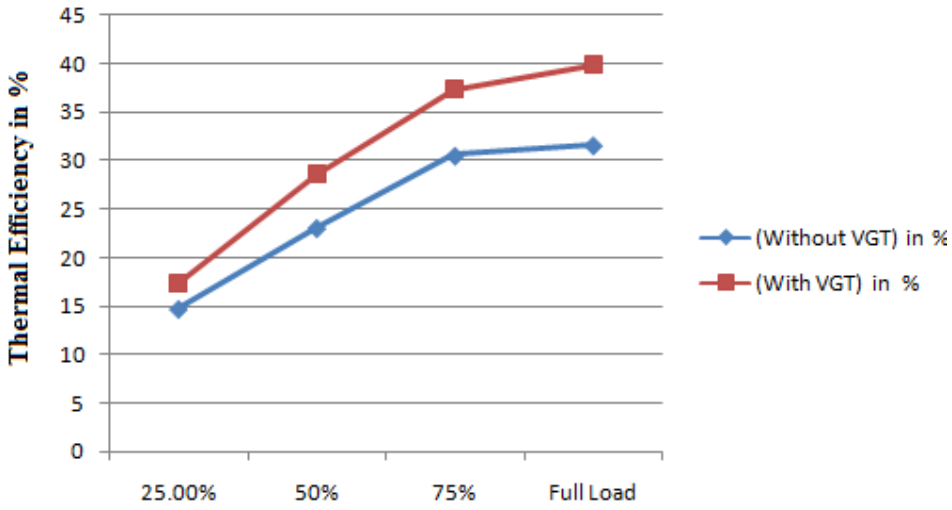
Graph 1 Brake power Vs Load

The change in Brake power of IC engine with respect to change in load on engine can be observed in the fig. 1. From this graph it can be observed that the brake power of the IC engine increases with increase in the load applied on the engine. The highest brake power produced is at full load condition of the IC engine. From this graph it can be also observed that the brake power of the IC engine increases with application of the variable geometry turbine. The variable geometry turbine forcefully induces air into the combustion chamber, this increases the pressure and temperature of air which is to be inducted into the combustion chamber which means with turbocharger more mass of air will be supplied to intake manifold and combustion chamber due to which more power will be produced by the engine. In this graph it is observed that the brake power of the IC engine increases by 4 % with application of variable geometry turbine.



Graph 2 BSFC Vs Load

The BSFC of IC engine with change in load and with use of variable geometry turbine can be observed from the graph 2. It can be observed in the graph that the BSFC of the IC engine decreases with increase in the load, this occurs due to fact that at high load engine is required to produce more power hence more fuel will be consumed at high engine load. Graph also shows that with application of Variable geometry turbine the BSFC of the IC engine decreases. The VGT induces more mass of air into the combustion chamber of the IC engine which lead to combustion of lean air fuel mixture into the combustion chamber. This decreases the requirement of fuel to produce power which further decreases the BSFC of the IC engine. In this study the BSFC of the IC engine at 25% load observed to be decreased by 15% with application of turbocharger, 19% for 50% load, 18% for 75% load and 21% for full load conditions.



Graph 3 Thermal Efficiency Vs Load

The thermal efficiency of IC engine with variation in engine load can be observed in graph 3. It also shows the effect of use of turbocharger on the thermal efficiency of the IC engine graph 3 shows that with increase in the engine load thermal efficiency of the IC engine increases and with use of VGT thermal efficiency increases. The thermal efficiency of the IC engine shows the effective conversion of heat into power. As more mass of air supplied to the combustion chamber less

fuel will be used which means less amount of heat is used. Hence with use of VGT thermal efficiency is increases. The results shows that the thermal efficiency of the IC engine at 25% load observed to be decreased by 17% with application of turbocharger, 23% for 50% load, 21% for 75% load and 25% for full load conditions.

5. Conclusions

In this research work the effect of Variable geometry turbine on the performance of an IC engine has been studied. The use variable geometry turbine provides many performance enhancements in the IC engines. The variable geometry turbine increases brake power of the IC engine by providing more mass of air to the combustion chamber and it also reduces fuel consumption of the IC engine. Brake power of the IC engine increases by 4 % and BSFC of the engine decreases by average value of 18.45%.

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